Report on projects within Theme 3

Franz-Josef Lübken and Joan Alexander
Actual status of projects:

1) Planetary and gravity wave influences upon the winter polar vortices (0-100 km)
   Alan Manson et al.

2) A global observing campaign to characterize tides and their influence from the troposphere to the thermosphere
   William Ward et al.

3) Gravity waves and turbulence
   Dave Fritts, Nikolai Gavrilov, Fan Yi et al.

4) Solar influence on minor constituents and layers at the extra-tropical summer mesopause
   Franz-Josef Lübken, Ulf-Peter Hoppe, Scott Bailey + t.b.d. (SH)

5) Ozone - how well do we really understand it?
   Marty Mlynczak, Martin Dameris et al.

6) Equatorial Atmosphere coupling processes (new title !)
   Mamoru Yamamotu, Hisao Takahashi, Subramanian Gurubaran+INTAR
New projects proposals (since last Wednesday):

Coupling effects in the electrodynamics at the low latitude ionosphere

a) Study of low latitude ionospheric disturbances associated with geomagnetic activity
   Archana Bhattacharyya, Art Richmond

b) Electrodynamical coupling of equatorial F region with conjugate E regions
   Hermann Lühr, Archana Bhattacharyya
Polar vortices project

Coordinators:
Alan Manson
ATMOSPHERIC WAVE INTERACTIONS WITH THE WINTER POLAR VORTICES (0-100 KM) ¹

- Sudden stratospheric warmings
- Mesospheric thermal inversions
- Equinoctial transitions
- “Ozone Anomalies”, and
- “Winter Anomaly” (D-region ionization)

¹ A CAWSES Project of Theme 3 “Atmospheric Coupling Processes” Co-ordinator Alan Manson Campaign 2004/5 Tatyana Chshyolkova
THE PROJECT

- Study polar vortices (0-100 km) in winter, in particular radiatively unexpected phenomena

- Observations and modeling

- 1st campaign in winter 2004/2005

- Planetary Waves, Tidal Waves, Gravity Waves
  Interactions with the mean flow

- Collaborations with other projects in Theme 3
  Collaboration with Theme “Solar influence on climate”
WORKING PLANS I

- Radars (*MFR, MWR*) and optical instruments: mid- and high-latitude + CPEA data

- Satellite missions: TIMED (TIDI, SABER), Odin (OSIRIS), ...

- MetO assimilated fields

- TIME-GCM and CMAM, with data assimilation
WORKING PLANS II
PARTICIPANTS

- Project Coordinator NH: Alan Manson
- Facilitator: Alan Manson
- Radar Steering Committee (NH): N. Mitchell, W. Singer, W. Hocking, D. Riggin, Yu. Portnyagin, C. Hall, A. Manson (Chair), and Y. Murayama
- Radar Steering Committee (SH): S. Palo (SH Coordinator), S. Avery, J. Forbes, R. Vincent, G. Fraser, D. Riggin, D. Fritts, M. Tsutsumi, T. Aso
PARTICIPANTS II

- Optical Coordinator (NH)  Marianna Shepherd

- Satellite Coordinators  D. Riggin, S. Palo et al. (TIMED-SABER and/or TIDI), and T. Llewellyn, D. Degenstein (Odin-OSIRIS)

- Models  R. Swinbank (MetO), M. Hagan (TIME-GCM, GSWM), T. Shepherd (CMAM), M. Salby and D. Ortland
**PROGRESS ON CAMPAIGN I**

- The data are available or coming soon from 13 radars, stretching from Yamagawa (31N) to Svalbard (78N)
- Analysis using wavelets and mean wind plots are completed as soon as the data arrive
- Preliminary results show that PW activity (>10 d) is greatest in Feb. & March. PW activity during the earlier part of the winter is low.
- MetO data are used to characterize winter vortex at stratospheric heights.
PROGRESS ON CAMPAIGN I
Tides project

Coordinators:
William Ward et al.
CAWSES Tidal Campaigns

Motivation

**MOTIVATION:**

- Sun generates tides through radiation
- Other mechanisms: e.g. latent heat release
- Tides are global, dominate dynamics, signatures in the entire atmosphere
- Requires global observations + modeling
- Ground based networks and satellite observations
- Global models are required
Monthly Average Temperature for Westward Diurnal Tide—Latitude Structure

Diurnal Tide (W) - T (K): W 1, M

Diur Tide - V (m/s): Wv1, MAF
Annual Cycle of Migrating Diurnal Tidal Temperature Amplitude
Purpose

• Provide global data sets for several concentrated time periods

• Get heating sources, tidal components, and tidal effects from the surface of the Earth to the ionosphere.

• Support and stimulate the analysis of these data sets.

• Support and stimulate the use of existing models and the development of new models to simulate the conditions during these campaigns and evaluate our understanding of this phenomenon.
Method

• Several 1 month campaigns during which radar, optical instrumentation, ionospheric observations and satellite data will be collected
• First campaign: October/November, 2005
• Two workshops
  1. observations, analysis of data
  2. modelling, understanding, evaluation
• Web based data centre
Organization

• Steering committee (organizing campaigns, contacting, setting up data set and analysis/modelling.

• Targeted observations include: Radar networks (Meteor, MF, IS), Optical instruments/networks ( imagers, interferometers, photometers, lidars), ionospheric observations (ionosondes, magnetometers, …), satellite observations (wind, temperature, constituents (water, ozone, oxygen), airglow).

• Committee membership includes:
Gravity wave and turbulence project

Coordinators:
Dave Fritts
Nikolai Gavrilow
Fan Yi
GW breaking complex, will contribute to parameterizations and meas. Interps.

- fast “local” instabilities
- slow “global” wave-wave interactions
Full viscous dispersion relation
MAC/WAVE project in summer 2002
Geophysical Research Letters

26 December 2004
Volume 31 Number 24
American Geophysical Union

Special Section: The McWAVE-MIDAS Program to Study the Polar Summer Mesosphere
Planned:

1. Campaign on mountain waves in Scandinavia
2. Satellite measurements of gravity waves
3. Ground based (lidar, radar, air glow) measurements of gravity waves
4. Continuation of detailed DNS simulation
5. Gravity wave parameterization studies
6. … more …
## CAWSES-WAVE RELATED STUDIES IN NIS COUNTRIES

<table>
<thead>
<tr>
<th>Institution</th>
<th>Research Fields</th>
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</table>
| Institute of Ionosphere, Almaty, Kazakhstan | 1. AGW from ionosonde data  
2. Observations and numerical modeling of ionospheric AGWs from tropospheric sources and explosions. |
| North-West IZMIRAN branch, Kaliningrad, Russia | Effects of solar eclipses and geomagnetic activity on atmospheric tides |
| Kaliningrad State University, Russia | Numerical modeling of IGW propagation and breaking in the middle and upper atmosphere |
| Kazan State University, Russia | Meteor radar observations and analysis of the mean wind, tides, planetary and gravity waves in the upper atmosphere |
| Saint-Petersburg State University, Russia | Analysis of GPS satellite and ground-based data, numerical modeling of gravity wave climatology |
Height-altitude crossections of mesoscale relative variances of atmospheric refractivity from CHAMP data averaged for years 2001-2005 and surface
## Wuhan University Fe Lidar Parameters (courtesy of Fan Yi)

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>Telescope diameter</td>
</tr>
<tr>
<td>372 nm</td>
<td>1 m</td>
</tr>
<tr>
<td>Linewidth</td>
<td>Field of view</td>
</tr>
<tr>
<td>1.8 GHz</td>
<td>1 mrad</td>
</tr>
<tr>
<td>Pulse energy</td>
<td>Bandwidth</td>
</tr>
<tr>
<td>40 m J</td>
<td>4 nm</td>
</tr>
<tr>
<td>Repetition rate</td>
<td>Altitude resolution</td>
</tr>
<tr>
<td>20 Hz</td>
<td>96 m</td>
</tr>
<tr>
<td>Pulse width</td>
<td>Time resolution</td>
</tr>
<tr>
<td>7 ns</td>
<td>5 min</td>
</tr>
<tr>
<td>Beam divergence</td>
<td></td>
</tr>
<tr>
<td>0.5 mrad</td>
<td></td>
</tr>
</tbody>
</table>
Ice layer project

Coordinators:
Franz-Josef Lübken
Ulf-Peter Hoppe
Scott Bailey

... and 1st campaign in summer 2005
Motivation and link to CAWSES

Study layers in MLT region because:

- summer mesosphere is special (cold!)
- … at the transition region between influence from above (Sun) and below
- layers: sensitive monitor of background
- „easy“ to observe; long records
- new techniques (data) + better understanding
- show solar cycle + trend(?) effects
- layers modify the background atmosphere
- … and more …
sun

H2O

nucleation

freeze drying

NLC  PMSE

ice

transport

transport

Chemical heating

photo dissociation

gemagnetic activity

super saturation

wind

temperature

energy and momentum budget

troposphere and stratosphere
NLC statistics from visual observations

Why phase shift?
Note: no trend!

after Gadsden (2002)
NLC observations at ALOMAR (69°N)

Note: no variation of NLC altitude!

Source: IAP (Fiedler et al., J. Geophys. Res. 2003)
Trend in PMC brightness (SBUVs)

Thomas, Olivero, Shettle,
PMSE: positive correlation with solar cycle

ROMA 2005 – 2\textsuperscript{nd} PMWE salvo

Lübken et al., submitted to Atmos. Chem. Phys., 2005
Solar max/min effect on H$_2$O

\[ R = \frac{f(H_2O)_{max}}{f(H_2O)_{min}} \]

von Zahn, Berger, et al., Atmos, Chem, Phys, 2004
Ice particle simulation with LIMA (IAP)
Open questions and scientific aims

• Study the effect of solar cycle (and trends) on layers (occurrence, brightness, altitude …)

• i.e. on composition, energy + momentum budget

• Study feedback mechanism of ice particles on background atmosphere (freeze drying)

• Explain observations:
  • why 1y phase shift ($\text{H}_2\text{O}$ and NLC) ?
  • why (no) trend at mid (high) latitudes ?
The summer 2005 campaign:
(F.-J. Lübken, Ulf-Peter Hoppe, Scott Bailey)
- Ice layer detection by lidars (NLC), radars (PMSE), and satellites (PMC)

- Trace gas measurements (most important: water vapour) from satellites and from ground-based instruments

- Temperature observations by ground-based and satellite-borne techniques

- Wind measurements by radars

- In situ measurements of plasma etc. by rockets

- 2005: close to solar minimum

- ENVISAT in high altitude mode: July 19-22 (i.e. NOW!)
- more satellites: ODIN, SNOE, TIMED, …
- Modelling
Together with ENVISAT and ODIN etc.
CAWSES
workshop on ice layers
and German DFG
15-19 May 2006
in Kühlungsborn
Ideas for future „campaigns“:

- a SH campaign

- SH/NH comparison (measurements, modelling, PMC, PMSE, NLC)

- modeling of solar influence and trends

- input from new insitu measurements of dust particles (MAGIC, ECOMA)

- etc.
Ozone project

Coordinators:
Marty Mlynczak, Martin Dameris
Concept for Ozone – Climate Influence

Solar Variability ($\lambda < 240$ nm)

- Ozone Abundance
  - Radiative Heating and Cooling
    - Lapse Rate of Temperature
      - Dynamics
        - Climate and Weather
The Golden Age of Ozone Sensing

First time ever, two satellites, continuously profiling ozone and related species, surface to 100 km altitude
Tracking Ozone Chemistry
Aura MLS
(Lower Stratosphere Layer)
13 Aug 2004

- Temperature
- Nitric Acid
- Chlorine Monoxide
- Hydrogen Chloride
- Ozone

Low
High
Equatorial Atmosphere coupling processes
(new title!)

Coordinators:
Mamoru Yamamoto
Subramanian Gurubaran
Hisao Takahashi
- CPEA Coupling processes in the equatorial atmosphere
  (several campaigns etc.; mainly Japan, Indonesia)
  (see report by Joan Alexander)

- Mesosphere-ionosphere coupling, formation of plasma bubbles
  (airglow, met radars, 1st campaign: Sept/Oct 2005; mainly Brazil, USA)

- **NEW**: Low latitude radar network for investigation of dynamical processes in the mesosphere-lower thermosphere region
  India (Gurubaran), Indonesia (t.b.d.), Japan (Tsuda, Nakamura), Brazil (Clemsha, Batista, Takahashi), UK (N. Mitchel, D. Pancheva), Australia (Vincent)

- **NEW**: INTAR (international tropical atmosphere radar network): troposphere
New projects:

• Coupling effects in the electrodynamics at the low latitude ionosphere

  a) Study of low latitude ionospheric disturbances associated with geomagnetic activity
     Archana Bhattacharyya, Art Richmond

  b) Electrodynamic coupling of equatorial F region with conjugate E regions
     Hermann Lühr, Archana Bhattacharyya

  c) Electrodynamical coupling at high latitudes (t.b.d.)

• t.b.d.: sprites, electric circuit
Theme 3 workshop in 2007
(With 4-5 key speakers from other Themes)

t.b.d.: when? where? who?
The End
CAWSES workshop on ice layers and German DFG 15-19 May 2006 in Kühlungsborn
Spares:
Tropospheric Ozone – Harvard GEOS Model – Boundary Layer

Harvard-GEOS Model: Ozone, $\sigma = 0.87$, ~1.1 km Above Surface
Month: Jul  Day: 01  GMT: 00

Ozone Volume Mixing Ratio

Courtesy TES Team/JPL
Correlation between half-hourly variances of ionospheric drift velocity for different seasons at Collm (Germany) after Jacobi et al., 2005 (presented at this conference)
The longest NLC since we measure (1997)

NLC: 0.20, 8
Theme 3: Atmospheric Coupling Processes

Co-Chairs: Franz-Josef Lübken (Germany) and Joan Alexander (USA)

WG 3.1: Dynamical Coupling and its Role in the Energy and Momentum Budget of the Middle Atmosphere

Martin Mlynczak (USA), William Ward, David Fritts (USA), Nikolai Gavrilov (Russia), S. Gurubaran (India), Maura Hagan (USA), J. Y. Liu (Taiwan), Alan Manson (Canada), Dora Pancheva (UK), Kauro Sato (Japan), Kazuo Shiokawa (Japan), Hisao Takahashi (Brazil), Robert Vincent (Australia) and Yi Fan (China)

WG 3.2: Coupling via Photochemical Effects on Particles and Minor Constituents in the Upper Atmosphere

Charles Jackman (USA), Ulf Hoppe (Norway), Manuel Lopez-Puertas (Spain), Daniel Marsh (USA), James Russell (USA), David Siskind (USA)

WG 3.3: Coupling by Electrodynamics including Ionospheric Magnetospheric Processes

Steve Cummer (USA), Peter L. Dyson (Australia), Inez S. Batista (Brazil), Archana Bhattacharya (India), Jorge Chau (Peru), Martin Fullekrug (Germany), Gang Lu (USA), Roland Tsunoda (USA), and M. Yamamoto (Japan)

+ Panel: Long-Term Trends (inter-connected with 4.4)